GRUNDFOS **INSTRUCTIONS**

Grundfos CIU 200

Modbus RTU for Grundfos CR Monitor

GB Functional profile and user manual

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Original installation and operating instructions.

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1. Symbols used in this document

Caution ***If these safety instructions are not observed, it may result in malfunction or damage to the equipment!***

Note ***Notes or instructions that make the job easier and ensure safe operation.***

2. Introduction

2.1 About this functional profile

This functional profile describes the CIU 200 (Modbus Communication Interface Unit 200) for the Grundfos CR Monitor.

In the following, the CIU 200 is referred to as "communication interface", and the Grundfos CR Monitor is referred to as "controller".

The data in this document are subject to change without prior notice. Grundfos cannot be held responsible for any problems caused directly or indirectly by using information in this functional profile.

2.2 Assumptions

This functional profile assumes that the reader is familiar with commissioning and programming Modbus devices. The reader should also have some basic knowledge of the Modbus protocol and technical specifications.

It is also assumed that an existing Modbus RTU network with a Modbus master is present.

2.3 Definitions and abbreviations

CIM 200	Communication Interface Module (built into the CIU 200)
CIU 200	Communication Interface Unit
CR	Grundfos multistage centrifugal pump
CRC	Cyclic Redundancy Check, a data error detection method
CRE	Grundfos multistage centrifugal pump with variable-speed motor
Derivation cable	Stub cable
GENIbus	Proprietary Grundfos fieldbus standard
H	Pressure (Head)
IO 351	Grundfos Input/Output module
LED	Light-Emitting Diode
Modbus	A serial communications protocol commonly used in industry and building services
MP 204	Electronic Grundfos Motor Protector
Q	Flow
RTU	Remote Terminal Unit
Transmission speed	Bits transferred per second
Trunk cable	Main RS-485 cable on Modbus network

2.4 System diagrams

The CR Monitor offers advanced monitoring of a Grundfos CRE pump or a Grundfos MP 204 motor protector connected to a CR pump.

The system diagrams give an overview of how to connect the CIU 200 to the Grundfos CR Monitor that is to be connected to a Modbus network. A CR Monitor is connected to either a CRE pump or an MP 204 connected to a CR pump. The CIU 200 has a number of sensor inputs that can be connected directly to sensors, or it can get sensor inputs from a Grundfos IO 351 module.

The CIU 200 offers a Modbus RTU connection to the CR Monitor. Note that the CR Monitor must have a GENIbus RS-485 module installed.

The CIU 200 solution is a box with a power supply module and a CIM 200 module. The CIU 200 can either be mounted on a DIN rail or on a wall. See fig. 1 or 2.

Grundfos CR Monitor and CRE

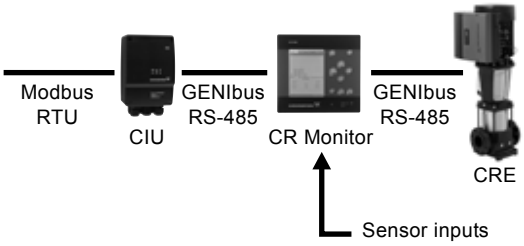

Fig. 1 CR Monitor connected to a CRE pump

Grundfos CR Monitor and MP 204 with CR

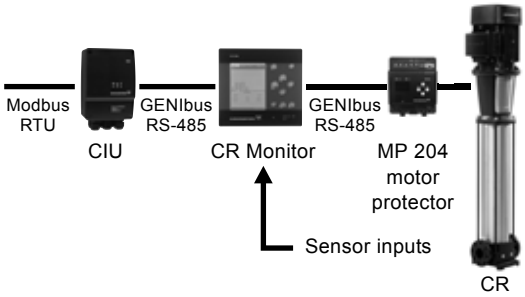

Fig. 2 CR Monitor connected to an MP 204 which is connected to a CR pump

2.5 Specifications

The table below gives an overview of the specifications for the Grundfos CIU 200. For further details, please refer to the specific sections of this functional profile.

General data		
GENIbus visual diagnostics	LED2	Off, constantly green, flashing red, constantly red. See section *4.7.2 LED2, internal communication*.
Communication Interface Unit (CIU 200)		
Power supply	24-240 V	Located in the CIU 200.
GENIbus connection type	RS-485	
GENIbus wire configuration	Three-wire + screen	Conductors: A, B and Y.
Modbus specifications		
Data protocol	Modbus RTU	
Modbus connector	Screw-type terminal	3 pins. See section *4. CIM 200 Modbus module*.
Modbus connection type	RS-485	
Modbus wire configuration	Two-wire + common	Conductors: D0, D1 and Common. See section *4.1 Connecting to the Modbus network*.
Maximum trunk cable length	1200 m	Equals 4000 ft.
Maximum derivation cable length	250 m (at 38400 bits/s)	Equals 820 ft.
Slave address	1-247	Set via rotary switches SW6 and SW7. See section *4.4 Modbus address selection*.
Line termination	On or Off	Set via DIP switches SW1 and SW2. See section *4.5 Termination resistor*.
Supported transmission speeds	1200*, 2400*, 4800*, 9600, 19200, 38400 bits/s	Set via DIP switches SW4 and SW5. See section *4.2 Setting the Modbus transmission speed*. (*Can only be set by software).
Start bit	1	Fixed value.
Data bits	8	Fixed value.
Stop bits	1 or 2	Set via DIP switch SW3. See section *4.3 Setting the parity*.
Parity bit	Even parity or no parity	Set via DIP switch SW3. See section *4.3 Setting the parity*.
Modbus visual diagnostics	LED1	Off, constantly green, flashing red, constantly red. See section *4.7.1 LED1, Modbus communication*.
Maximum number of Modbus devices	32	Using repeaters, this number can be increased. Address range is 1-247.

3. Modbus interface

3.1 Modbus bus topology

The Grundfos CIM/CIU 200 is connected as a Modbus slave directly to the Modbus RTU network. This is done either in daisy chain style, or using a passive TAP and a derivation cable (stub). Both methods are exemplified below.

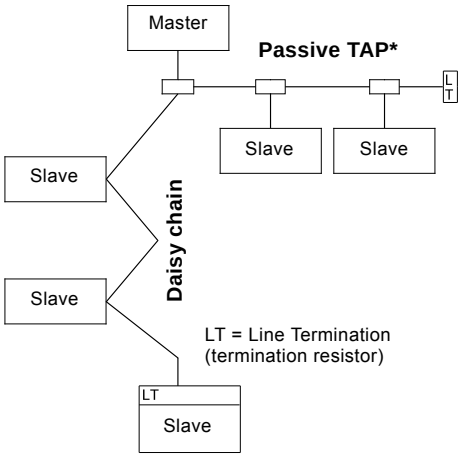

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Fig. 3 Example of Modbus network with termination

In such a network, only one master device is connected to the serial bus, and one or several (maximum 247) slaves are also connected to the serial bus. Slaves cannot communicate with each other and will never transmit data without receiving a request from the master device.

Up to 32 devices can be connected to one RS-485 Modbus system without using a repeater. To implement a larger number of devices, use a repeater to connect the smaller networks to larger networks. Repeaters are also used to extend the maximum transmission distance.

4. CIM 200 Modbus module

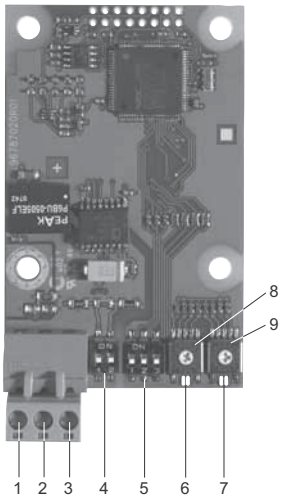

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Fig. 4 CIM 200 Modbus module

Pos.	Designation	Description
1	D1	Modbus terminal D1 (positive data signal)
2	D0	Modbus terminal D0 (negative data signal)
3	Common/GND	Modbus terminal Common/GND
4	SW1/SW2	On/off switches for termination resistor
5	SW3/SW4/SW5	Switches for selection of Modbus parity and transmission speed
6	LED1	Red/green status LED for Modbus communication
7	LED2	Red/green status LED for internal communication between the CIM 200 and the CR Monitor
8	SW6	Hex switch for setting the Modbus address (four most significant bits)
9	SW7	Hex switch for setting the Modbus address (four least significant bits)

4.1 Connecting to the Modbus network

A screened, twisted-pair cable must be used. The cable screen must be connected to protective earth at both ends.

Recommended connection

Modbus terminal	Colour code	Data signal
D1-TXD1	Yellow	Positive
D0-TXD0	Brown	Negative
Common	Grey	Common/GND

4.2 Setting the Modbus transmission speed

The transmission speed must be set correctly before the CIM 200 Modbus module is ready to communicate with the Modbus network. DIP switches SW4 and SW5 are used for setting the transmission speed. See fig. 5.

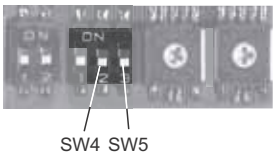

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Fig. 5 Modbus transmission speed setting

4.2.1 DIP switch settings

Available transmission speeds in bits/s: 1200, 2400, 4800, 9600, 19200 and 38400.

The first three transmission speeds are only available via software settings, whereas the last three are available via DIP switches SW4 and SW5.

Transmission speed	SW4	SW5
9600 bits/s	OFF	ON
19200 bits/s	OFF	OFF
38400 bits/s	ON	OFF
Software-defined	ON	ON

The default transmission speed is 19200 bits per second, as per the Modbus RTU standard.

The transmission speed will be effective immediately after setting the values of the DIP switch.

Software-defined

When SW4 and SW5 are set to "software-defined", writing a value to the holding register at address 00004 will set a new transmission speed.

Use the following values for software-defined transmission speeds:

Software-defined transmission speed	Set register value 00004
1200 bits/s	0
2400 bits/s	1
4800 bits/s	2
9600 bits/s	3
19200 bits/s	4
38400 bits/s	5

This value is set to 1200 bits/s as default.

The communication interface does not support transmission speeds above 38400 bits/s.

The software-defined transmission speed value will be stored in the communication interface and will remain after a power-off.

Note ***When software-defined transmission speed is enabled (ON), software-defined parity and stop bit are also enabled.***

4.3 Setting the parity

The parity can be set either manually by using SW3 or via software-defined settings.

Manual setting of parity

The CIM 200 only supports the Modbus RTU mode and hence cannot communicate with Modbus ASCII mode devices.

Default byte format (11 bits):

- 1 start bit
- 8 data bits (least significant bit sent first)
- 1 parity bit (even parity)
- 1 stop bit.

The default setting of the CIM 200 Modbus module is even parity (1 stop bit). It is possible to change the parity with DIP switch SW3. The parity can be changed to no parity (2 stop bits). See fig. 6.

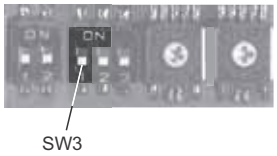

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Fig. 6 Parity

DIP switch settings

Parity	SW3
Even parity, 1 stop bit	OFF
No parity, 2 stop bits	ON

Software-defined parity and stop bit

When SW4 and SW5 are set to "software-defined", the value in holding registers at addresses 00009 and 00010 will override the setting of SW3. See figs 5 and 6.

Software-defined parity	Set register value 00009
No parity [default]	0
Even parity	1
Odd parity	2

Software-defined stop bit	Set register value 00010
1 stop bit [default]	1
2 stop bits	2

The software-defined parity and stop bit values will be stored in the communication interface and will remain after a power-off.

Note ***Before the parity and stop bit can be set via software-defined settings, SW4 and SW5 must be set to ON.***

4.4 Modbus address selection

A Modbus slave on a Modbus network must have a unique address from 1 to 247. Address 0 is reserved for broadcasting, and is not a valid slave address.

To set the Modbus address, two hexadecimal rotary switches (SW6 and SW7) are used. See fig. 7.

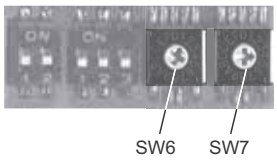

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Fig. 7 Setting the Modbus address

For a complete overview of Modbus addresses, see section *11. Modbus address* on page 22.

Note ***The Modbus address must be set decimally from 1 to 247.***

4.5 Termination resistor

The termination resistor is fitted on the CIM 200 Modbus module and has a value of 150 Ω.

The CIM 200 has a DIP switch with two switches (SW1 and SW2) for cutting the termination resistor in and out. Figure 8 shows the DIP switches in cut-out state.

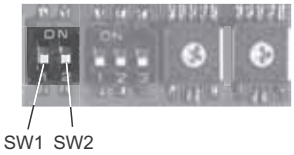

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Fig. 8 Cutting the termination resistor in and out

DIP switch settings

Status	SW1	SW2
Cut-in	ON	ON
Cut-out	OFF	OFF
	ON	OFF
	OFF	ON

Default setting: Termination resistor cut-out.

4.6 Cable length

The trunk cable must not exceed a total length of 1,200 m (4,000 ft).

Grundfos recommends the following maximum cable lengths:

bits/s	Maximum cable length	
	Terminated cable	Unterminated cable
	[m/ft]	[m/ft]
9600 bits/s	1200/4000	1200/4000
19200 bits/s	1200/4000	500/1700
38400 bits/s	1200/4000	250/800

Note ***To ensure a stable and reliable communication, it is important that only the termination resistor of the first and last units in the Modbus network are cut in. See fig. 3.***

4.7 LEDs

The CIM/CIU 200 has two LEDs.

- Red/green status LED (LED1) for Modbus communication between master and slave
- Red/green status LED (LED2) for internal communication between the CIM/CIU 200 and the CR Monitor.

4.7.1 LED1, Modbus communication

Status	Description
Off	No Modbus communication.
Flashing green	Modbus communication active.
Flashing red	Fault in the Modbus communication.
Constantly red	Fault in the CIM 200 Modbus configuration.

4.7.2 LED2, internal communication

Status	Description
Off	The CIM/CIU 200 has been switched off, or is starting up.
Flashing red	No internal communication between the CIM/CIU 200 and the CR Monitor.
Constantly red	The CIM/CIU 200 does not support the CR Monitor connected.
Constantly green	Internal communication between the CIM/CIU 200 and the CR Monitor is OK.

Note ***During start-up, there may be a delay of up to 5 seconds before the LED2 status is updated.***

Note ***The CR Monitor must have finished its start-up sequence before the LED2 can be used for status. This means that a certain delay may occur before the LED2 turns green after start-up of the CR Monitor.***

5. Functional profile

5.1 Register block overview

The Modbus RTU registers are grouped in the following register blocks:

Start address	Register block	Permissions	Description
00001	CIM configuration	R/W	Configuration of the CIM module.
00021	CIM status	R	Status registers for the CIM module.
00101	CR Monitor control	R/W	Registers for control of the CR Monitor and the pump.
00201	CR Monitor status	R	Registers for reading mode status from the CR Monitor and the pump.
00301	CR Monitor data	R	Registers for reading measured data values from the CR Monitor and the pump.

All addresses contain registers. Some are bit-interpreted while others are 16-bit values, or part of 32-bit values.

5.2 CIM configuration register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

Address	Register name	Description
00001	SlaveMinimumReplyDelay	The minimum reply delay from the slave in ms. Value range: 0-10000, i.e. up to 10 seconds reply delay. This delay is typically used in conjunction with a modem. The delay value is stored in the device and will remain after a power-off. The delay set here will be added to the internal delay in the device. Default value is 0.
00002	RegisterOffset	An address offset that is added to all addresses above 00100. Default value is 0. **Note:** This offset does not affect the CIM configuration register block or the CIM status register block addresses. The register offset value is stored in the device and will remain after a power-off. For most applications, this offset should not be changed.
00003	SoftwareDefinedModbusAddress	If the Modbus address switch has not been set correctly, i.e. not within the 1 to 247 range, the value in this register is used as Modbus address. See section *4.4 Modbus address selection*. The value is stored in the device and will remain after a power-off. Default value of this register is 0xE7 (231).
00004	SoftwareDefinedBitRate	Modbus software-defined transmission speed enumeration. The software-defined transmission speed value is stored in the device and will remain after a power-off. 0 = 1200 bits/s 1 = 2400 bits/s 2 = 4800 bits/s 3 = 9600 bits/s 4 = 19200 bits/s 5 = 38400 bits/s. **Note:** This value is used only when the transmission speed is set to "software-defined" on the DIP switches SW4 and SW5. Otherwise, it will be ignored by the slave.
00005	AutoAckControlBits	Used to select the behaviour of control bit acknowledgements from the CIU 200. 0 = Disabled. Control bits are not automatically lowered when accepted by the device. The user must lower the triggered control bit manually before the control bit can be triggered again. 1 = Enabled. Control bits are automatically lowered when accepted by the device. The user does not have to lower it manually [default].
00006	RESERVED	-
00007	RESERVED	-
00008	RESERVED	-
00009	SoftwareDefinedParity	Parity setting to be used when using "software-defined" settings. 0 = No parity [default] 1 = Even parity 2 = Odd parity.
00010	SoftwareDefinedStopBit	Stop bit setting to be used when using "software-defined" settings. 0 = No stop bit 1 = 1 stop bit [default] 2 = 2 stop bits.

5.3 CIM status register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only. This block can be used for various kinds of fault finding.

Address	Register name	Description
00021	GrundfosCRCErrorCnt	Holds a CRC error counter for the GENIbus connection between the CIU 200 and the CR Monitor.
00022	GrundfosDataErrorCnt	Holds a data error counter for the GENIbus connection between the CIU 200 and the CR Monitor.
00023	VersionNumber	A Grundfos-specific version number. This is an unsigned integer value.
00024	ActualModbusAddress	Holds the current Modbus slave address of the device. Valid value range: 1…247.
00025 00026	GrundfosTXcountHI GrundfosTXcountLO	Holds a transmit counter for total number of telegrams sent to the CIU 200 on the GENIbus connection.
00027 00028	GrundfosRXcountHI GrundfosRXcountLO	Holds a receive counter for total number of telegrams received from the CIU 200 on the GENIbus connection.
00029	RESERVED	-
00030	UnitFamily	Grundfos product family.
00031	UnitType	Grundfos product type.
00032	UnitVersion	Grundfos product version.

5.4 CR Monitor control register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

Address	Register name	Description
00101	ControlRegister Bits 3-15: RESERVED	-
	ControlRegister Bit 2: ResetAlarm	Control bit that resets alarms and warnings. 0 = No resetting 1 = Resetting alarm. This control bit is triggered on rising edge only, i.e. setting logical 0 to 1. See section *5.2 CIM configuration register block*, address 00005, for acknowledgement behaviour.
	ControlRegister Bit 1: OnOffReq	Control bit that switches the pump/MP 204 on and off. 0 = Off (stop) 1 = On (start).
	ControlRegister Bit 0: RemoteAccessReq	Control bit that sets local or remote control. 0 = Local 1 = Remote (controlled by Modbus master). This bit must be 1 if the pump/MP 204 is to be controlled by a Modbus master.
00102	ControlMode	Sets the control mode enumeration. 0 = CONST_SPEED (constant speed) 1 = CONST_FREQ (constant frequency) 3 = CONST_HEAD (constant head) 4 = CONST_PRESSURE (constant pressure) 5 = CONST_DIFFPRESS (constant differential pressure) 6 = VAR_DIFFPRESS (variable differential pressure) 7 = CONST_FLOW (constant flow) 8 = CONST_TEMP (constant temperature) 10 = CONST_LEV (constant level) 128 = AUTO_PRESS_MODE (automatic mode). See section *6.1 Control modes* for details.
00103	OperationMode	A state enumeration to control the pump operating mode. 0 = Auto-control (setpoint control) 4 = OpenLoopMin (running at minimum speed) 6 = OpenLoopMax (running at maximum speed). **Note:** OnOffReq has higher priority than the OperationMode, meaning that OnOffReq must be set to on for the OperationMode to have any effect. See section *6.1 Control modes* for details.
00104	Setpoint	Sets the pump setpoint (not used on systems with MP 204). Scale is 0.01 %, with value range [0; 10000]. **Closed loop** Percentage of closed-loop feedback sensor range. **Open loop** Percentage of pump performance. **Common examples** 4700 = 47 % 8000 = 80 %. See section *6.2 Setpoint*.

5.5 CR Monitor status register block

Registers in this register block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Address	Register name	Description
00201	StatusRegister Bit 15: AtMinSpeed	Indicates if the CRE pump is running at minimum speed. 0 = No 1 = Yes. *Not available on the CR pump.*
	StatusRegister Bit 14: RESERVED	-
	StatusRegister Bit 13: AtMaxSpeed	Indicates if the CRE pump is running at maximum speed. 0 = No 1 = Yes. *Not available on the CR pump.*
	StatusRegister Bit 12: RESERVED	-
	StatusRegister Bit 11: Warning	Indicates if there is a warning or not. The pump will continue running even if there is a warning. 0 = No warning 1 = Warning.
	StatusRegister Bit 10: Fault	Indicates if there is a fault or not. 0 = No fault 1 = Fault.
	StatusRegister Bit 9: OnOff	Indicates if the pump is on or not. 0 = Off (stopped) 1 = On (started). Started does not necessarily indicate rotation, for instance in case of low-flow stop.
	StatusRegister Bit 8: AccessMode	Indicates if the pump is locally or remotely controlled. 0 = Local (a local control source with higher priority controls the pump). 1 = Remote (controlled by Modbus master).
	StatusRegister Bit 7: RESERVED	-
	StatusRegister Bit 6: Rotation	Indicates if the pump is rotating (running) or not. 0 = No rotation 1 = Rotation.
	StatusRegister Bits 4-5: RESERVED	-
	StatusRegister Bit 3: ResetAlarmAck	Indicates if a ResetAlarm was acknowledged by the device. This bit will be set when the CIU 200 has accepted the ResetAlarm control bit, and the user can clear the ResetAlarm bit. The CIU 200 will automatically clear the ResetAlarmAck bit to 0 when the user clears the ResetAlarm bit, and a new ResetAlarm can be attempted by raising the ResetAlarm control bit again. 0 = No acknowledgement 1 = Control bit acknowledged. This functionality is only used when AutoAckControlBits is disabled. See section *5.2 CIM configuration register block*.
	StatusRegister Bits 0-2: RESERVED	-
00202	ProcessFeedback	Indicates the actual process feedback from the CRE pump. The scale is 0.01 %, so the valid value range is from 0 to 10000. This value can be compared with the setpoint value. **Closed loop** Percentage of closed-loop feedback sensor range. **Open loop** Percentage of CRE pump performance. **Common examples** 4700 = 47 % 8000 = 80 %.
00203	ControlMode	Indicates the actual control mode. 0 = CONST_SPEED (constant speed) 1 = CONST_FREQ (constant frequency) 3 = CONST_HEAD (constant head) 4 = CONST_PRESSURE (constant pressure) 5 = CONST_DIFFPRESS (constant differential pressure) 6 = VAR_DIFFPRESS (variable differential pressure) 7 = CONST_FLOW (constant flow) 8 = CONST_TEMP (constant temperature) 10 = CONST_LEV (constant level) 128 = AUTO_PRESS_MODE (automatic mode).

Address	Register name	Description
00204	OperationMode	Indicates the actual operating mode. 0 = Auto-control (setpoint control) 4 = OpenLoopMin (running at minimum speed) 6 = OpenLoopMax (running at maximum speed).
00205	AlarmCode	The Grundfos-specific alarm code. See section *10. Grundfos alarm and warning codes*.
00206	WarningCode	The Grundfos-specific warning code. See section *10. Grundfos alarm and warning codes*.
00207	Bits 9-15: RESERVED	-
	Bit 8: BearingServiceType	Indicates the type of the next bearing service. 0 = Lubricate bearings 1 = Change bearings.
	Bits 0-7: MonthsToBearingService	Indicates the number of months until the next bearing service. *This value can be 0, 1, 3, 6, 12 and 24 months, if available. A value of 24 months means "24 months or more". A value of 0xFF indicates that the information is not available.*
00208.0	MonitorLearningActivated	Indicates the activation status of the CR Monitor learning function. 0 = Not activated 1 = Activated.
00208.1	MonitorLearningOperating	Indicates the operating status of the CR Monitor learning function. 0 = Not operating 1 = Operating.
00208.2	MonitorLearningDataQuality	Indicates the data stability of the CR Monitor learning function. 0 = Unstable data 1 = Stable data.
00209	ControllerFaults	Indicates controller faults. Bit 0: RESERVED Bit 1: FLASH parameter verification error (code 83) Bit 2: Ethernet: No IP address from DHCP server (code 231) Bit 3: Ethernet: Auto-disabled due to misuse (code 232).
00210	MonitorAlarms1	Alarm bits for the monitoring system. Bit 0: Maximum inlet pressure alarm limit exceeded Bit 1: Minimum inlet pressure alarm limit exceeded Bit 2: Maximum discharge pressure alarm limit exceeded Bit 3: Minimum discharge pressure alarm limit exceeded Bit 4: Maximum differential-pressure alarm limit exceeded Bit 5: Minimum differential-pressure alarm limit exceeded Bit 6: Maximum flow alarm limit exceeded Bit 7: Minimum flow alarm limit exceeded Bit 8: Maximum supply voltage alarm limit exceeded Bit 9: Minimum supply voltage alarm limit exceeded Bit 10: Maximum speed alarm limit exceeded Bit 11: Minimum speed alarm limit exceeded Bit 12: Maximum power alarm limit exceeded Bit 13: Minimum power alarm limit exceeded Bit 14: Minimum efficiency alarm limit exceeded Bit 15: Minimum cavitation alarm limit exceeded.
00211	MonitorAlarms2	Alarm bits for the monitoring system. Bit 0: Maximum Q, H alarm limit exceeded Bit 1: Maximum Q, P alarm limit exceeded Bit 2: Start trip counter alarm limit exceeded Bit 3: Maximum lubrication time alarm limit exceeded Bit 4: RESERVED Bit 5: RESERVED Bit 6: Pump fault Bits 7-15: RESERVED.
00212	MonitorWarnings1	Warning bits for the monitoring system. Bit 0: Maximum inlet pressure warning limit exceeded Bit 1: Minimum inlet pressure warning limit exceeded Bit 2: Maximum discharge pressure warning limit exceeded Bit 3: Minimum discharge pressure warning limit exceeded Bit 4: Maximum differential-pressure warning limit exceeded Bit 5: Minimum differential-pressure warning limit exceeded Bit 6: Maximum flow warning limit exceeded Bit 7: Minimum flow warning limit exceeded Bit 8: Maximum supply voltage warning limit exceeded Bit 9: Minimum supply voltage warning limit exceeded Bit 10: Maximum speed warning limit exceeded Bit 11: Minimum speed warning limit exceeded Bit 12: Maximum power warning limit exceeded Bit 13: Minimum power warning limit exceeded Bit 14: Minimum efficiency warning limit exceeded Bit 15: Minimum cavitation warning limit exceeded.

Address	Register name	Description
00213	MonitorWarnings2	Warning bits for the monitoring system. Bit 0: Maximum Q, H warning limit exceeded Bit 1: Maximum Q, P warning limit exceeded Bit 2: Start trip counter warning limit exceeded Bit 3: Maximum lubrication time warning limit exceeded Bit 4: RESERVED Bit 5: RESERVED Bit 6: Pump warning Bits 7-15: RESERVED.
00214	MP 204Warnings1	Warning bits for MP 204, if installed. Bit 0: Maximum voltage warning Bit 1: Minimum voltage warning Bit 2: Maximum line current warning Bit 3: Minimum line current warning Bit 4: Line current asymmetry warning Bit 5: RESERVED Bit 6: RESERVED Bit 7: RESERVED Bit 8: Insulation resistance warning Bit 9: Motor temperature (Tempcon) warning Bit 10: Motor temperature (PT resistor) warning Bit 11: RESERVED Bit 12: Maximum cos φ warning limit exceeded Bit 13: Minimum cos φ warning limit exceeded Bit 14: Starts per hour warning Bit 15: Starts per hour warning limit exceeded.
00215	MP 204Warnings2	Warning bits for MP 204, if installed. Bit 0: Start capacitor min. warning Bit 1: RESERVED Bit 2: Run capacitor min. warning Bit 3: Tempcon sensor signal fault warning Bit 4: Pt sensor signal fault warning Bit 5: Service warning: t_run_trip_cnt > t_run_trip_warn Bit 6: Load continues even if the motor has been switched off Bits 7-15: RESERVED.

5.6 CR Monitor data register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only. The table below shows the availability of the data, depending on system configuration.

Address	Register name	Scale
00301	InletPressure (offset = 1 bar)	0.001 bar
00302	OutletPressure	0.001 bar
00303	VolumeFlow	0.1 m^3/h
00304	Speed	1 rpm
00305	Frequency	0.1 Hz
00306	DigitalInput	bits
00307	DigitalOutput	bits
00308	ActualSetpoint Available with CRE pump only.	0.01 %
00309	MotorCurrent	0.1 A
00310	MotorTemp Available if a Pt100 sensor is used.	0.01 K
00311	MotorVoltage	0.1 V
00312	CalculatedPower	1 W
00313 00314	PowerHI PowerLO	1 W
00315	PumpLiquidTemp	0.01 K
00316	AuxSensorInput	0.01 %
00317 00318	OperationTimeHI OperationTimeLO	1 hour
00319 00320	TotalPoweredTimeHI TotalPoweredTimeLO	1 hour
00321 00322	EnergyHI EnergyLO	1 kWh
00323 00324	NumberOfStartsHI NumberOfStartsLO	1 start
00325	DifferentialPressure	0.001 bar
00326	CalculatedDifferentialPressure	0.001 bar
00327	CalculatedEfficiency	0.01 %
00328	MeasuredEfficiency	0.01 %
00329	NPSHAvailable	0.01 m
00330	NPSHRequired	0.01 m
00331	CavitationMargin	0.01 m

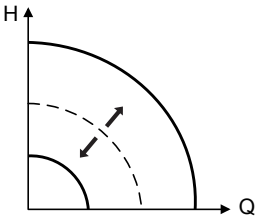
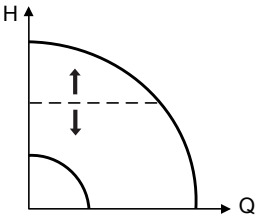
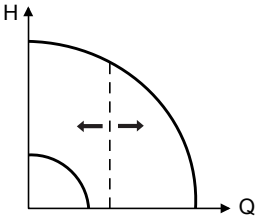
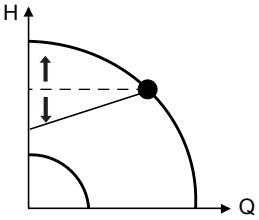
A data value of 0xFFFF indicates "not available".

See section *9. Data item overview* for more information on this register block.

6. Detailed descriptions

6.1 Control modes

The supported control modes are described further in this section.

Control modes	Description	Illustration
> CONST_SPEED > CONST_FREQ	**Open loop** The setpoint of the CRE pump will be interpreted as setpoint for the pump speed. The setpoint value is a percentage of the maximum speed of the pump. No sensor is required in these modes.	 TM04 2289 2208
> CONST_HEAD > CONST_PRESSURE > CONST_DIFFPRESS	**Closed loop** The setpoint of the CRE pump will be interpreted as setpoint for the pressure. The controller in the pump will change the pump speed so that the pressure is constant, regardless of the flow. A pressure sensor is required.	 TM04 2290 2208
> CONST_FLOW > CONST_TEMP > CONST_LEV	**Closed loop** The setpoint of the CRE pump will be interpreted as setpoint for the flow, temperature or level. CONST_FLOW is illustrated to the right. A relevant sensor is required: • a temperature sensor for temperature control, • a level sensor for level control and • a flow sensor for flow control.	 TM04 2288 2208
> VAR_DIFFPRESS	**Closed loop** The setpoint of the CRE pump will be interpreted as basic setpoint for the VAR_DIFFPRESS mode (the black dot in the drawing). This control mode is only available on TPE Series 2000 pumps. A pressure sensor is required.	 TM04 2291 2208

H = Pressure (Head)

Q = Flow

6.2 Setpoint

This register accepts values ranging from 0 to 10000 (0 % to 100 %). This is illustrated in fig. 9. The setpoint is a percentage of the maximum setpoint or sensor maximum (max. = 100 %). The setpoint value can represent speed, pressure, flow, etc., depending on the selected control mode.

A setpoint of 0 does not imply a stop.

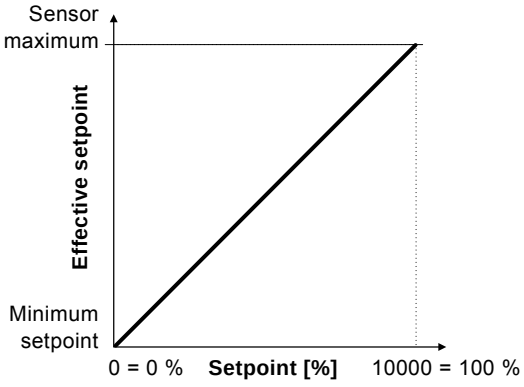


Fig. 9 Setpoint

6.2.1 Control modes

Closed loop

If the control mode is set to CONST_PRESS (closed loop), and the pressure sensor is in the range of 0 to 10 bar, a setpoint of 80 % will result in an effective setpoint of 8 bar.

If the sensor range was 0-16 bar, a 50 % setpoint would be 8 bar, a 25 % setpoint would be 4 bar, and so on.

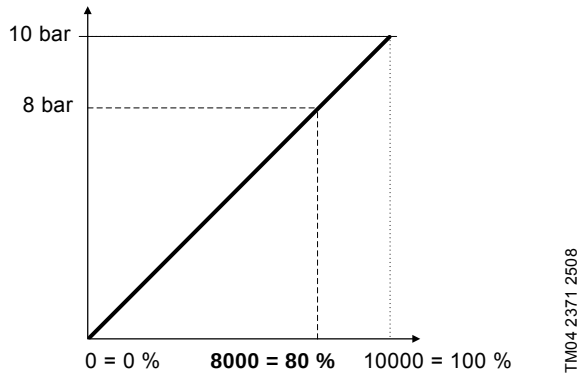


Fig. 10 Constant pressure

Open loop

If the control mode is set to CONST_FREQ (open loop), the setpoint is interpreted as setpoint for the system performance.

The example shows that a 50 % setpoint equals a 50 % system performance.

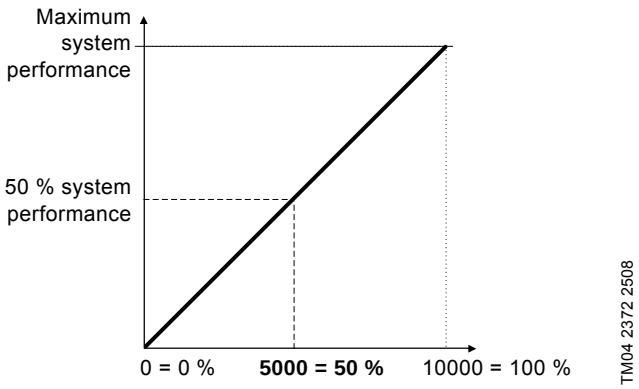


Fig. 11 Constant frequency

7. Commissioning

Note ***If the sensor configuration is changed, restart the CIU 200 to ensure a correct scaling of the sensor value.***

7.1 Step-by-step guide to hardware setup (CIU 200)

Step	Description
1	Complete the CR Monitor system configuration, e.g. sensor configuration.
2	Select the Modbus slave address (1-247). See section *4.4 Modbus address selection*.
3	Select the transmission speed of the Modbus slave. See section *4.2 Setting the Modbus transmission speed*.
4	Select parity and stop bits of the Modbus slave (even-1 or none-2). See section *4.3 Setting the parity*.
5	If necessary, set line termination. See section *4.5 Termination resistor*.
6	Connect the GENIbus cable from the CIU 200 to the CR Monitor.
7	Connect the necessary cables from the CIU 200 to the Modbus network. See section *4.1 Connecting to the Modbus network*.
8	Connect the power supply cable to the CIU 200, and switch the unit on.
9	Confirm that the GENIbus LED is constantly green and that the Modbus LED is either off (if no master is actively polling the slave) or flashing green (indicating communication). See section *4.7 LEDs*.
The CIU 200 is now ready to be accessed via the Modbus network.	

8. Fault finding

8.1 LED Status

Faults in a CIM/CIU 200 can be detected by observing the status of the two communication LEDs. See the table below.

Fault (LED status)	Possible cause	Remedy
1. Both LEDs (LED1 and LED2 remain off when the power supply is connected and 5 seconds have passed.	a) The CIM 200 is defective.	• Replace the CIM 200.
2. The LED for internal communication (LED2) is flashing red.	a) No internal communication between the CIM/CIU 200 and the Grundfos CR Monitor.	• Check the cable connection between the CR Monitor and the CIU 200. • Check that the individual conductors have been fitted correctly. • Check the power supply to the CR Monitor.
3. The LED for internal communication (LED2) is constantly red.	a) The CIU 200 does not support the CR Monitor connected.	• Contact the nearest Grundfos company.
4. The Modbus LED (LED1) is constantly red.	a) Fault in the CIM 200 Modbus configuration.	• Check the transmission speed (switches SW4 and SW5). If the switches are set to "software-defined", an invalid value may have been set via Modbus. Try one of the pre-selected transmission speeds, e.g. 19200 bits/s. • Check that the Modbus address (switches SW6 and SW7) has a valid value (1-247).
5. The Modbus LED (LED1) is flashing red.	a) Fault in the Modbus communication (fault in parity or cyclic redundancy check).	• Check the transmission speed (switches SW4 and SW5). • See section *4.2 Setting the Modbus transmission speed*. • Check the parity setting (switch SW3). See section *4.3 Setting the parity*. • Check the cable connection between the CIM 200 and the Modbus network. • Check the termination resistor settings (switches SW1 and SW2). See section *4.5 Termination resistor*.

8.2 Modbus communication faults

Fault	Possible cause	Remedy
1. The slave does not respond to telegrams.	a) Configuration or wiring error.	• Check the visual diagnostics on the Modbus slave. Is the Grundfos GENIbus LED flashing green and the Modbus LED off or flashing green. • Ensure that the cable between the Modbus master and the Modbus slave is connected correctly. See section *4.1 Connecting to the Modbus network* for wiring recommendations. • Ensure that the slave address is configured correctly, and that the correct slave address is used in the Modbus master poll. See section *4.4 Modbus address selection* for slave address selection. • Ensure that the transmission speed and stop bit/parity settings are configured correctly in both master and slave. See sections *4.2 Setting the Modbus transmission speed* and *4.3 Setting the parity*. • Ensure that each end of the Modbus trunk cable is terminated, if necessary. See section *4.5 Termination resistor* for line termination of the Grundfos slave. • Ensure that the bus topology for a Modbus network is correct. See section *3.1 Modbus bus topology*.
	b) The slave may be in listen-only mode.	• Either send a restart communications diagnostics command, or restart the CIU 200 manually.
	c) If the holding register of address 00001 "SlaveMinimumReplyDelay" is set too high, the master may time out before receiving the response from the slave.	• Increase the timeout span in the master in order to communicate.
2. The slave responds with exception response 0x01: "Invalid function".	a) The master is trying to use an unsupported function in the CIM/CIU 200.	• See section *12.2 Function code overview* for supported function codes. Note that reading and writing coils are not supported, so only register functions and diagnostics will be valid.
3. The slave responds with exception response 0x02: "Invalid data address".	a) The master is trying to read or write an invalid data address. If a master tries to read register addresses that are not listed in the tables, the slave will respond with this exception response. Some masters may automatically try to read large blocks in one telegram, which will cause problems if some of the registers in the block are not supported. An example would be reading the CIM configuration and CIM status register blocks in one telegram: this is not possible since there are unused addresses between the blocks.	• Avoid reading or writing invalid data addresses.
	b) The register address offset may have been changed from default.	• Read the holding register at address 00002 "RegisterOffset" to see if this value is different from 0. If so, write the value 0 to this address to make the slave return to the default used in this functional profile.
4. The slave returns data value 0xFFFF (65535).	a) The value is unavailable. A data value of 0xFFFF does not necessarily indicate an error condition. It means that the value is unavailable from the CR Monitor.	• See section *9. Data item overview* for available data.
	b) The CR Monitor is not configured to show the value or lacks a sensor to read the value.	• Ensure that the CR Monitor has been configured appropriately.
5. The slave does not change Modbus transmission speed with register 0004.	a) Configuration error.	• Set the transmission speed switches to "software-defined". Otherwise, the value in register 0004 is ignored by the slave.
	b) An invalid value may have been set in register 00004.	• See section *4.2 Setting the Modbus transmission speed* for invalid values, and set correct value in register 00004.

9. Data item overview

bits: The data item is bit-interpreted.

enum: The data item has a pre-defined enumeration.

unscaled: The data item is unscaled (e.g. a number, a counter, etc.).

The list shows data item functionality support for a CR Monitor connected to either a CRE pump or an MP 204 and a CR pump.

Register	Identifier	Scale	R/W	Description	CR Monitor + CRE	CR Monitor + MP 204 and CR
CIM configuration register block						
00001	SlaveMinimumReplyDelay	ms	R/W	Minimum Modbus reply delay in ms.	•	•
00002	RegisterOffset	unscaled	R/W	Modbus address offset.	•	•
00003	ModbusAddress	unscaled	R/W	Is used if the rotary switch value is invalid.	•	•
00004	ModbusBitRate	unscaled	R/W	Software-defined transmission speed.	•	•
00005	AutoAckControlBits	bool	R/W	Setup of event acknowledgement behaviour.	•	•
00009	SoftwareDefinedParity	enum	R/W	Parity setting in "software-defined" mode.	•	•
00010	SoftwareDefinedStopBit	enum	R/W	Stop bit setting in "software-defined" mode.	•	•
CIM status register block						
00021	GrundfosCRCErrorCnt	unscaled	R	Grundfos GENIbus CRC error counter.	•	•
00022	GrundfosDataErrorCnt	unscaled	R	Grundfos GENIbus data error counter.	•	•
00023	VersionNumber	unscaled	R	Version number.	•	•
00024	ActualModbusAddress	unscaled	R	Actual Modbus slave address.	•	•
00025 00026	GrundfosTXcountHI GrundfosTXcountLO	unscaled	R	Grundfos GENIbus transmit counter.	•	•
00027 00028	GrundfosRXcountHI GrundfosRXcountLO	unscaled	R	Grundfos GENIbus receive counter.	•	•
00030	UnitFamily	unscaled	R	Grundfos product family.	•	•
00031	UnitType	unscaled	R	Grundfos product type.	•	•
00032	UnitVersion	unscaled	R	Grundfos product version.	•	•
CR Monitor control register block						
00101	ControlRegister	bits	W	Control register for pump control.	•	•
00102	ControlMode	enum	W	Sets the control mode.	•	-
00103	OperationMode	enum	W	Sets the operating mode.	•	•
00104	Setpoint	0.01 %	W	Reference value (pump setpoint).	•	-
CR Monitor status register block						
00201	StatusRegister	bits	R	Actual modes.	•	•
00202	ProcessFeedback	0.01 %	R	Actual process feedback value.	•	-
00203	ControlMode	enum	R	Readout of the actual control modes.	•	•
00204	OperationMode	enum	R	Readout of the actual operating mode.	•	•
00205	AlarmCode	enum	R	Actual fault code/alarm code.	•	•
00206	WarningCode	enum	R	Actual warning code.	•	•
00207	ServiceBlock	bits	R	Bearing service information.	•	•
00208	MonitorLearning	bits	R	Learning functions of the CR Monitor.	•	•
00209	ControllerFaults	bits	R	Fault bits from the controller.	•	•
00210	MonitorAlarms1	bits	R	Alarm bits for the monitoring system.	•	•
00211	MonitorAlarms2	bits	R	Alarm bits for the monitoring system.	•	•
00212	MonitorWarnings1	bits	R	Warning bits for the monitoring system.	•	•
00213	MonitorWarnings2	bits	R	Warning bits for the monitoring system.	•	•
00214	MP 204Warnings1	bits	R	Warning bits for the MP 204.	-	•
00215	MP 204Warnings2	bits	R	Warning bits for the MP 204.	-	•
CR Monitor data register block						
00301	InletPressure	0.001 bar	R	Pump inlet pressure. Has offset of -1.0 bar.	•	•
00302	OutletPressure	0.001 bar	R	Pump discharge pressure.	•	•
00303	VolumeFlow	0.1 m^3/h	R	Actual pump flow.	•	•
00304	Speed	1 rpm	R	Motor speed.	•	•
00305	Frequency	0.1 Hz	R	Actual control signal applied to motor.	•	•

Register	Identifier	Scale	R/W	Description	CR Monitor + CRE	CR Monitor + MP 204 and CR
00306	DigitalInput	bits	R	External digital input signals.	•	•
00307	DigitalOutput	bits	R	External digital output signals.	•	•
00308	ActualSetpoint	0.01 %	R	Actual setpoint (reference).	•	•
00309	MotorCurrent	0.1 A	R	Motor current.	•	•
00310	MotorTemp	0.01 K	R	Motor winding temperature.	•	•
00311	MotorVoltage	0.1 V	R	Motor voltage.	•	•
00312	CalculatedPower	1 W	R	Calculated power consumption.	•	•
00313 00314	MeasuredPowerHI MeasuredPowerLO	1 W	R	Measured power consumption.	•	•
00315	PumpLiquidTemp	0.01 K	R	Pumped-liquid temperature.	•	•
00316	AuxSensorInput	0.01 %	R	Auxiliary sensor input.	•	•
00317 00318	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the pump.	•	•
00319 00320	TotalPoweredTimeHI TotalPoweredTimeLO	1 hour	R	Total power-on time of the pump.	•	•
00321 00322	EnergyHI EnergyLO	1 kWh	R	Energy consumption.	•	•
00323 00324	NumberOfStartsHI NumberOfStartsLO	unscaled	R	Total number of starts.	•	•
00325	DifferentialPressure	0.001 bar	R	Pressure rise across the pump.	•	•
00326	CalculatedDifferentialPressure	0.001 bar	R	Calculated pressure across the pump based on model.	•	•
00327	CalculatedEfficiency	0.01 %	R	Calculated efficiency based on model.	•	•
00328	MeasuredEfficiency	0.01 %	R	Measured efficiency.	•	•
00329	NPSHAvailable	0.01 m	R	Net Positive Suction Head available at the pump inlet.	•	•
00330	NPSHRequired	0.01 m	R	Net Positive Suction Head required by Grundfos data.	•	•
00331	CavitationMargin	0.01 m	R	NPSH available (NPSHRequired + safety margin).	•	•

10. Grundfos alarm and warning codes

This is a general Grundfos alarm and warning code list. Not all codes are available in the CR Monitor.

Code	Description	Code	Description	Code	Description
1	Leakage current	35	Gas in pump head, deaerating problem	76	Internal communication fault
2	Missing phase	36	Discharge valve leakage	77	Communication fault, twin-head pump
3	External fault signal	37	Suction valve leakage	78	Fault, speed plug
4	Too many restarts	38	Vent valve defective	79	Functional fault, add-on module
5	Regenerative braking	40	Undervoltage	80	Hardware fault, type 2
6	Mains fault	41	Undervoltage transient	81	Verification error, data area (RAM)
7	Too many hardware shutdowns	42	Cut-in fault (dV/dt)	82	Verification error, code area (ROM, FLASH)
8	PWM switching frequency reduced	45	Voltage asymmetry	83	Verification error, FE parameter area (EEPROM)
9	Phase sequence reversal	48	Overload	84	Memory access error
10	Communication fault, pump	49	Overcurrent (i_line, i_dc, i_mo)	85	Verification error, BE parameter area (EEPROM)
11	Water-in-oil fault (motor oil)	50	Motor protection function, general shutdown (mpf)	88	Sensor fault
12	Time for service (general service information)	51	Blocked motor/pump	89	Signal fault, (feedback) sensor 1
13	Moisture alarm, analog	52	Motor slip high	90	Signal fault, speed sensor
14	Electronic DC-link protection activated (ERP)	53	Kipped motor	91	Signal fault, temperature 1 sensor
15	Communication fault, main system (SCADA)	54	Motor protection function, 3 sec. limit	92	Calibration fault, (feedback) sensor
16	Other	55	Motor current protection activated (MCP)	93	Signal fault, sensor 2
17	Performance requirement cannot be met	56	Underload	94	Limit exceeded, sensor 1
18	Commanded alarm standby (trip)	57	Dry running	95	Limit exceeded, sensor 2
19	Diaphragm break (dosing pump)	58	Low flow	96	Setpoint signal outside range
20	Insulation resistance low	59	No flow	97	Signal fault, setpoint input
21	Too many starts per hour	64	Overtemperature	98	Signal fault, input for setpoint influence
22	Moisture switch alarm, digital	65	Motor temperature 1 (t_m or t_mo or t_mo1)	99	Signal fault, input for analog setpoint
23	Smart trim gap alarm	66	Temperature, control electronics (t_e)	104	Software shutdown
24	Vibration	67	Temperature too high, internal frequency converter module (t_m)	105	Electronic rectifier protection activated (ERP)
25	Setup conflict	68	External temperature/ water temperature (t_w)	106	Electronic inverter protection activated (EIP)
26	Load continues even if the motor has been switched off	69	Thermal relay 1 in motor (e.g. Klixon)	110	Skew load, electrical asymmetry
27	External motor protector activated (e.g. MP 204)	70	Thermal relay 2 in motor (e.g. thermistor)	111	Current asymmetry
28	Battery low	71	Motor temperature 2 (Pt100, t_mo2)	112	Cos φ too high
29	Turbine operation (impellers forced backwards)	72	Hardware fault, type 1	113	Cos φ too low
30	Change bearings (specific service information)	73	Hardware shutdown (HSD)	120	Auxiliary winding fault (single-phase motors)
31	Change varistor(s) (specific service information)	74	Internal supply voltage too high	121	Auxiliary winding current too high (single-phase motors)
32	Overvoltage	75	Internal supply voltage too low	122	Auxiliary winding current too low (single-phase motors)

Code	Description	Code	Description	Code	Description
123	Start capacitor, low (single-phase motors)	183	Signal fault, extra temperature sensor	215	Soft pressure build-up timeout
124	Run capacitor, low (single-phase motors)	184	Signal fault, general-purpose sensor	216	Pilot pump alarm
144	Motor temperature 3 (Pt100, t_mo3)	185	Unknown sensor type	217	Alarm, general-purpose sensor high
145	Bearing temperature high (Pt100), in general or top bearing	186	Signal fault, power meter sensor	218	Alarm, general-purpose sensor low
146	Bearing temperature high (Pt100), middle bearing	187	Signal fault, energy meter	219	Pressure relief not adequate
147	Bearing temperature high (Pt100), bottom bearing	188	Signal fault, user-defined sensor	220	Fault, motor contactor feedback
148	Motor bearing temperature high (Pt100) in drive end (DE)	189	Signal fault, level sensor	221	Fault, mixer contactor feedback
149	Motor bearing temperature high (Pt100) in non-drive end (NDE)	190	Sensor limit 1 exceeded (e.g. alarm level in WW application)	222	Time for service, mixer
152	Communication fault, add-on module	191	Sensor limit 2 exceeded (e.g. high level in WW application)	223	Maximum number of mixer starts per hour exceeded
153	Fault, analog output	192	Sensor limit 3 exceeded (e.g. overflow level in WW application)	224	Pump fault (due to auxiliary component or general fault)
154	Communication fault, display	193	Sensor limit 4 exceeded	225	Communication fault, pump module
155	Inrush fault	194	Sensor limit 5 exceeded	226	Communication fault, I/O module
156	Communication fault, internal frequency converter module	195	Sensor limit 6 exceeded	227	Combi event
157	Real-time clock out of order	196	Operation with reduced efficiency	228	Not used
158	Hardware circuit measurement fault	197	Operation with reduced pressure	229	Not used
159	CIM fault (Communication Interface Module)	198	Operation with increased power consumption	230	Network alarm
160	GSM modem, SIM card fault	199	Process out of range (monitoring/ estimation/calculation/control)	231	Ethernet: No IP address from DHCP server
168	Signal fault, pressure sensor	200	Application alarm	232	Ethernet: Auto-disabled due to misuse
169	Signal fault, flow sensor	201	External sensor input high	233	Ethernet: IP address conflict
170	Signal fault, water-in-oil (WIO) sensor	202	External sensor input low	236	Pump 1 fault
171	Signal fault, moisture sensor	203	Alarm on all pumps	237	Pump 2 fault
172	Signal fault, atmospheric pressure sensor	204	Inconsistency between sensors	238	Pump 3 fault
173	Signal fault, rotor position sensor (Hall sensor)	205	Level float switch sequence inconsistency	239	Pump 4 fault
174	Signal fault, rotor origo sensor	206	Water shortage, level 1	240	Lubricate bearings (specific service information)
175	Signal fault, temperature 2 sensor (t_mo2)	207	Water leakage	241	Motor phase failure
176	Signal fault, temperature 3 sensor (t_mo3)	208	Cavitation	242	Automatic motor model recognition failed
177	Signal fault, Smart trim gap sensor	209	Non-return valve fault	243	Motor relay has been forced (manually operated/commanded)
178	Signal fault, vibration sensor	210	Overpressure	244	Fault, On/Off/Auto switch
179	Signal fault, bearing temperature sensor (Pt100), general or top bearing	211	Underpressure	245	Pump continuous runtime too long
180	Signal fault, bearing temperature sensor (Pt100), middle bearing	212	Diaphragm tank precharge pressure out of range	246	User-defined relay has been forced (manually operated/ commanded)
181	Signal fault, PTC sensor (short-circuited)	213	VFD not ready	247	Power-on notice (device/system has been switched off)
182	Signal fault, bearing temperature sensor (Pt100), bottom bearing	214	Water shortage, level 2	248	Fault, battery/UPS

11. Modbus address

Modbus address	SW 6	SW 7
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	A
11	0	B
12	0	C
13	0	D
14	0	E
15	0	F
16	1	0
17	1	1
18	1	2
19	1	3
20	1	4
21	1	5
22	1	6
23	1	7
24	1	8
25	1	9
26	1	A
27	1	B
28	1	C
29	1	D
30	1	E
31	1	F
32	2	0
33	2	1
34	2	2
35	2	3
36	2	4
37	2	5
38	2	6
39	2	7
40	2	8
41	2	9
42	2	A
43	2	B
44	2	C
45	2	D
46	2	E
47	2	F
48	3	0
49	3	1
50	3	2

Modbus address	SW 6	SW 7
51	3	3
52	3	4
53	3	5
54	3	6
55	3	7
56	3	8
57	3	9
58	3	A
59	3	B
60	3	C
61	3	D
62	3	E
63	3	F
64	4	0
65	4	1
66	4	2
67	4	3
68	4	4
69	4	5
70	4	6
71	4	7
72	4	8
73	4	9
74	4	A
75	4	B
76	4	C
77	4	D
78	4	E
79	4	F
80	5	0
81	5	1
82	5	2
83	5	3
84	5	4
85	5	5
86	5	6
87	5	7
88	5	8
89	5	9
90	5	A
91	5	B
92	5	C
93	5	D
94	5	E
95	5	F
96	6	0
97	6	1
98	6	2
99	6	3
100	6	4

Modbus address	SW 6	SW 7
101	6	5
102	6	6
103	6	7
104	6	8
105	6	9
106	6	A
107	6	B
108	6	C
109	6	D
110	6	E
111	6	F
112	7	0
113	7	1
114	7	2
115	7	3
116	7	4
117	7	5
118	7	6
119	7	7
120	7	8
121	7	9
122	7	A
123	7	B
124	7	C
125	7	D
126	7	E
127	7	F
128	8	0
129	8	1
130	8	2
131	8	3
132	8	4
133	8	5
134	8	6
135	8	7
136	8	8
137	8	9
138	8	A
139	8	B
140	8	C
141	8	D
142	8	E
143	8	F
144	9	0
145	9	1
146	9	2
147	9	3
148	9	4
149	9	5
150	9	6

Modbus address	SW 6	SW 7
151	9	7
152	9	8
153	9	9
154	9	A
155	9	B
156	9	C
157	9	D
158	9	E
159	9	F
160	A	0
161	A	1
162	A	2
163	A	3
164	A	4
165	A	5
166	A	6
167	A	7
168	A	8
169	A	9
170	A	A
171	A	B
172	A	C
173	A	D
174	A	E
175	B	F
176	B	0
177	B	1
178	B	2
179	B	3
180	B	4
181	B	5
182	B	6
183	B	7
184	B	8
185	B	9
186	B	A
187	B	B
188	B	C
189	B	D
190	B	E
191	B	F
192	C	0
193	C	1
194	C	2
195	C	3
196	C	4
197	C	5
198	C	6
199	C	7
200	C	8

Modbus address	SW 6	SW 7
201	C	9
202	C	A
203	C	B
204	C	C
205	C	D
206	C	E
207	C	F
208	D	0
209	D	1
210	D	2
211	D	3
212	D	4
213	D	5
214	D	6
215	D	7
216	D	8
217	D	9
218	D	A
219	D	B
220	D	C
221	D	D
222	D	E
223	D	F
224	E	0
225	E	1
226	E	2
227	E	3
228	E	4
229	E	5
230	E	6
231	E	7
232	E	8
233	E	9
234	E	A
235	E	B
236	E	C
237	E	D
238	E	E
239	E	F
240	F	0
241	F	1
242	F	2
243	F	3
244	F	4
245	F	5
246	F	6
247	F	7

Example: To set the slave address to the value 142, set the rotary switches SW6 and SW7 to "8" and "E", respectively.
Please note that 0 is not a valid slave address as this is used for broadcasting.

Caution ***It is very important to ensure that two devices do not have the same address on the network. If two devices have the same address, the result will be an abnormal behaviour of the whole serial bus.***

12. Modbus telegrams and function codes

12.1 Modbus telegram overview

The maximum size of a Modbus RTU telegram is 256 bytes. Telegrams must be separated by a silent interval of at least 3.5 character times.

The standard Modbus RTU frame format is shown in the table below.

Slave address	Function code	Data	CRC
1 byte	1 byte	0 to 252 bytes	2 bytes

A telegram starts with the slave address occupying one byte. The function code comes next (see section *12.2 Function code overview* for supported function codes). Then comes a variable-size data field. For each telegram, a CRC is calculated and appended to the telegram (two bytes total). All bytes in the telegram, except for the CRC itself, are included in the check.

Note ***The CRC bytes are not shown in the examples in the following sections.***

12.2 Function code overview

The table below shows a list of the supported function codes.

Type	Code	Hex	Name
16-bit data (registers)	03	0x03	Read holding registers
	04	0x04	Read input registers
	06	0x06	Write single registers
	16	0x10	Write multiple registers
Diagnostics	08	0x08	Diagnostics See section *12.7 Diagnostics (0x08)* for subcodes.

Note ***Reading or writing coils are not supported.***

The same data are available in both holding registers and input registers, meaning that either function (0x03 or 0x04) can be used for reading data.

12.3 Read holding registers (0x03)

This function is used for reading holding registers from the slave.

The request telegram specifies the starting address (the address of the first register to be read) and the number of holding registers to read. In the telegram, register addresses start from zero, meaning that registers numbered 0-16 are addressed as 0-15.

The register data in the response message are packed two bytes per register. For each register, the first byte contains the high-order bits while the second byte contains the low-order bits.

Example of request from master to slave

Address	Function code	Start address HI	Start address LO	Quantity HI	Quantity LO
0x01	0x03	0x00	0x6B	0x00	0x03

In the request, the slave with address 1 is asked to deliver three contiguous registers starting from address 0x006b = 107 (meaning register 108).

Example of response from slave to master

Address	Function code	Byte count	Register 108 HI	Register 108 LO	Register 109 HI	Register 109 LO	Register 110 HI	Register 110 LO
0x01	0x03	0x06	0x00	0x01	0x00	0x01	0x00	0x01

In the response, the byte count is six since there are three registers of two bytes. All three registers hold the value of 0x0001.

12.4 Read input registers (0x04)

This function is used for reading input registers from the slave. Input registers are read-only registers by definition. The request telegram specifies the starting address (the address of the first register to be read) and the number of holding registers to read. In the telegram, register addresses start from zero, meaning that registers numbered 0-16 are addressed as 0-15.

The register data in the response message are packed two bytes per register. The first byte contains the high-order bits and the second byte contains the low-order bits.

Example of request from master to slave

Address	Function code	Start address HI	Start address LO	Quantity HI	Quantity LO
0x01	0x04	0x10	0x10	0x00	0x03

In the request, the slave with address 1 is asked to deliver three contiguous registers starting from address 0x1010 = 4112 (meaning register 4113).

Example of response from slave to master

Address	Function code	Byte count	Register 4113 HI	Register 4113 LO	Register 4114 HI	Register 4114 LO	Register 4115 HI	Register 4115 LO
0x01	0x04	0x06	0x22	0x22	0x22	0x22	0x22	0x22

In the response, the byte count is six since there are three registers of two bytes. All three registers hold the value of 0x2222.

12.5 Write single register (0x06)

This function is used for writing a single holding register in the slave. The request telegram specifies the address of the register that is to be written. Register addresses start from zero, meaning that a register numbered 10 is addressed as 9.

The normal response is an echo of the request, indicating that the value was written.

Example of request from master to slave

Address	Function code	Address HI	Address LO	Value HI	Value LO
0x01	0x06	0x10	0x00	0xAF	0xFE

In the request, the slave with address 1 is asked to write the value of 0xAFFE to the register with address 0x1000.

Example of response from slave to master

Address	Function code	Address HI	Address LO	Value HI	Value LO
0x01	0x06	0x10	0x00	0xAF	0xFE

The response is an echo of the request.

12.6 Write multiple registers (0x10)

This function is used for writing a block of contiguous holding registers in the slave. Register addresses start from zero, meaning that a register numbered 100 is addressed as 99.

Address	Function code	Start address HI	Start address LO	Qty HI	Qty LO	Byte count	Register 33 HI	Register 33 LO	Register 34 HI	Register 34 LO
0x01	0x10	0x00	0x20	0x00	0x01	0x04	0x00	0x01	0xB0	0xB0

In the request, the slave with address 1 is asked to write the value of 0x0001 to the register at address 0x0020 and the value of 0xB0B0 to the register at address 0x0021.

Example of response from slave to master

Address	Function code	Start address HI	Start address LO	Qty written HI	Qty written LO
0x01	0x10	0x00	0x20	0x00	0x02

The response returns the function code, starting address and quantity of registers written.

12.7 Diagnostics (0x08)

This function provides a test for checking the communication system between the master and the Grundfos slave. It contains a single-byte subcode to identify the test to be performed.

The following subcodes are supported:

Subcode	Name
0x00	Return query data Data in this request are to be echoed in the response. The response must be identical to the request, so this function is often used to verify Modbus communication.
0x01	Restart communications All communications counters are cleared, and the device is restarted.
0x02	Return diagnostics register Returns the 16-bit diagnostics register. See section *12.8 Diagnostics register interpretation*.
0x04	Force Listen Only Forces the device into listen-only mode. This effectively mutes the device, making it unable to communicate on the network. To bring the device back to normal mode, a "Restart Communications" command (code 0x08, subcode 0x01) must be issued.
0x0A	Clear counters and diagnostics register Clears all counters and the diagnostics register. (These are also cleared on power-up/restart).
0x0B	Return bus message count Returns the number of messages detected by the slave.
0x0C	Return bus CRC error count Returns the number of CRC errors in the slave.
0x0D	Return bus exception count Returns the number of Modbus exception responses that the slave has transmitted.
0x0E	Return slave message count Returns the number of messages that the slave has processed.
0x0F	Return slave no response count Returns the number of messages for which the slave has sent no response.
0x12	Return bus character overrun count Returns the number of overruns in the slave.
0x14	Clear overrun counter Clears the overrun counter. (This is also cleared on power-up/restart).

Example of response from master to slave

Address	Function code	Subcode	Data	Data
0x01	0x08	0x00	0xAB	0xCD

The response is identical to the request.

Example of response from slave to master

Address	Function code	Subcode	Data	Data
0x01	0x08	0x00	0xAB	0xCD

12.8 Diagnostics register interpretation

The diagnostics register is interpreted as follows:

Bit	Description
0	Communication failure (from the CIU 200 to the Grundfos CR Monitor).
1	EEPROM self-test failed (the test is carried out when the system is booted).
2	Grundfos CR Monitor version not supported.
3	Modbus address offset is different from default value, i.e. it differs from 0.
4	Using software-defined Modbus transmission speed.
5	RESERVED
6	RESERVED
7	RESERVED
8	RESERVED
9	RESERVED
10	RESERVED
11	RESERVED
12	RESERVED
13	RESERVED
14	RESERVED
15	RESERVED

A bit value of 1 means true, unless otherwise specified. The diagnostics register is read using function code 0x08 and subcode 0x02.

13. Modbus telegram examples

Note ***CRC fields are not shown in the following examples.***

Note ***The Modbus data model states that registers numbered X are addressed in telegrams as X - 1, e.g. register 00104 (setpoint) is addressed as 00103 in a Modbus telegram.***

13.1 Diagnostics return query data

This function is useful to ensure that the communication path and slave configuration are correct. It will echo the request in the response.

In the example, slave address 0x01 is used.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x08	Diagnostics
Subcode	0x00	Echo request
Data	0xAB	Test data
Data	0xCD	Test data

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x08	Diagnostics
Subcode	0x00	Echo request
Data	0xAB	Test data
Data	0xCD	Test data

If there is no response from the slave, see section *8.2 Modbus communication faults*.

13.2 Reading the CIM configuration register block

This section shows how to read the first four registers of the CIM configuration register block.

In the example, slave address 0x01 is used.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Start address HI	0x00	Start address = 0x0001
Start address LO	0x00	
Quantity HI	0x00	Number of registers = 0x0004
Quantity LO	0x04	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Byte count	0x08	8 bytes follow
00001 HI	0x00	SlaveMinimumReplyDelay = 0x000A
00001 LO	0x0A	
00002 HI	0x00	RegisterOffset = 0x0000
00002 LO	0x00	
00003 HI	0x00	Reserved value = 0x0000
00003 LO	0x00	
00004 HI	0x00	ModbusBitRate = 0x0004
00004 LO	0x04	

If there is no response from the slave, see section *8.2 Modbus communication faults*.

13.3 Setting the setpoint

This section shows how to set a new setpoint (reference) in the communication interface.

In the example, slave address 0x01 is used, and a value of 55 % (5500 = 0x157C) is set as new setpoint.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	Setpoint address = 00104 (0x0068)
Start address LO	0x67	
Value HI	0x15	New setpoint value = 5500 (0x157C)
Value LO	0x7C	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	Setpoint address = 00104 (0x0068)
Start address LO	0x67	
Value HI	0x15	New setpoint value = 5500 (0x157C)
Value LO	0x7C	

If there is no response from the slave, see section *8.2 Modbus communication faults*.

13.4 Setting the control mode

This section shows how to set a new control mode.

In the example, slave address 0x01 is used, and the control mode is set to 1, meaning constant frequency (CONST_FREQ).

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlMode address = 00102 (0x0066)
Start address LO	0x65	
Value HI	0x00	New ControlMode value = 1 (0x0001)
Value LO	0x01	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlMode address = 00102 (0x0066)
Start address LO	0x65	
Value HI	0x00	New ControlMode value = 1 (0x0001)
Value LO	0x01	

If there is no response from the slave, see section *8.2 Modbus communication faults*.

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